JPRS L/10127

19 November 1981

USSR Report

TRANSPORTATION

(FOUO 7/81)

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CONTENTS

MISCELLANEOUS

METRO IN TWENTY CITIES: 50TH ANNIVERSARY OF SOVIET SUBWAY CONSTRUCTION

Moscow METROSTROY in Russian No 3,1981 pp 6-18

[Article by A. Lugovtsov, chief of Metrogiprotrans: "50th Anniversary of Soviet Subway Construction: The Subway in Twenty Cities"]

[Excerpts] The Moscow Metrostroy [Administration for Construction of the Moscow Subway], which is celebrating its semicentennial, has become the springboard for development of Soviet subways. The main directions of their planning and construction were the basis of this interview with A. S. Lugovtsov, chief of the lead Metrogiprotrans [exact expansion unknown] planning and surveying institute:

[Answer] It can be said definitively that the future of many major cities is linked with construction of a subway. During the last decade the number of cities in the country with a population of over a million persons doubled. Just from data of the All-Union Survey of 1979, 18 cities have surpassed the one-million level of inhabitants, and six have come close. In the majority of cases the crossing of this threshold complicates the solution to the surface transport problem. Social need thus poses the task of expanding the geography of the most effective form of public transport--an off-street form providing mass high-speed, regular, comfortable transportation.

The subway, born of the city's needs, becomes an active part of its life in the very period of its formation and later becomes an important city-forming factor by giving rise to certain construction activities. Today it is difficult to picture Moscow, Leningrad, Kiev, Tbilisi, Baku, Khar'kov and Tashkent without high-speed underground lines. The Moscow Subway System is constantly increasing the overall length of the network. It will increase 29.4 km in the present five-year plan.

The Leningrad Subway is celebrating its 25th anniversary, the Kiev its 20th, and the Tbilisi its 15th. During every 24-hour period the 46 station lobbies of the city on the Neva and the 127 escalators deliver up to two million persons to the underground platforms. Three high-speed tunnel routes interconnect practically all rayons of the city. In Kiev, Tbilisi and Baku, where two lines each already are in operation, the subway takes up to one-third of citywide transportation.

A subway has opened in Yerevan. The prestartup time is approaching in Minsk, Gor'kiy and Novosibirsk. Preparatory and tunneling work has begun in Kuybyshev, Sverdlovsk and Dnepropetrovsk. Feasibility studies are being drawn up for subways in Rostov-na-Donu, Alma-Ata, Omsk, Chelyabinsk and Perm'. A TEO [feasibility study] already has been approved for Riga.

The overall amount of construction and installation work in subway construction will rise 45 percent in the current five-year plan in comparison with the previous plan. The start-up of some 100 km of new lines is planned.

[Question] Anatoliy Stepanovich! Tell us how hydrogeological and other local features affect a solution to key technical problems, the selection of methods of performing the work, planning and technological structures, and the configuration of transport complexes as a whole.

[Answer] There are no cities with identical geological engineering, urban development and other conditions, let alone combinations of these conditions. Every new city where a subway is born is a new page in planning and construction, an invariable creative search and enrichment of experience previously obtained.

For example, in surveying the Tashkent subway route, we encountered an unusual soil environment: unstable loessial rock. This required the development of effective steps to design reliable foundations for facilities and continuous tunneling. The hot climate made it necessary to create special ventilation systems. A zone of high seismicity left an imprint on the nature of tunnel components, which were made of sectional elements with rigid and yielding joint connections and reinforcing seismic bands.

All these tasks had to be accomplished for the first time in our practice.

In its three years of operation, the Tashkent Subway has withstood 25 earthquakes with an intensity to 6, and it must be said that it withstood them excellently.

Let's take Minsk, which is not such an exotic example. The unique planning pattern of its center--two almost equivalent city nuclei stand out along the basic architectural axis--forced more than one version of track construction to be studied. The geology forced the acceptance of shallow tunnels (usually deep tunnels are more preferable in a densely built-up center with monuments of historical architecture). There was a threat that surface transport would be shut down for the period of construction.

But the optimum design solution was found. In conformity with it, future transfer complexes were located in the most important passenger-originating junctions. One of the central stations was laid out in the plan so that it would be able to receive simultaneous passenger flows from Lenin Square and the railroad station (at first we assumed it was possible to erect only subway stations of the second section in the vicinity of the train station). Construction of shallow runs of tunnels was envisaged as being by the covered method convenient for the city. The nonsag tunneling is done by a unit with a set of equipment for erecting a continuous pressed concrete casing, designed in our institute. A significant part of the line under construction already has been developed successfully.

A new "bouquet" of special features has been identified now in the TEO development stage of subways in Rostov-na-Donu and Alma-Ata, and they are forcing us to seek an appropriate approach both to the question of drawing up a general arrangement for high-speed underground transportation in each of these cities, and to selection of the depth of the routes. In Alma-Ata in particular the deep layers (Quaternary deposits) literally are larded with boulders. And in Rostov-na-Donu it will be necessary to undertake capital mining work under rather narrow streets, in unstable, water-saturated soils, and with a difficult crossing of the Don and its tributary. In all probability, shallow tunneling is contraindicated here, but deep tunneling is fraught with serious technical complications. What is to be done? We are deciding. There are no ready-made solutions.

The conditions of Dnepropetrovsk advance a different range of problems: obtaining a smooth contour of the tunneling, mechanization of the building of deeply embedded single-vault stations in fractured granites, and so on.

[Question] The Soviet school of subway planning is based on the diverse experience in building them in different cities around the country. What long-range developments are contained in the latest plans of Metrogiprotrans and its affiliates?

[Answer] I would have to answer this question rather diffusely. I'll note the most important ones. Among them are the compact transfer junctions of the combined type according to the direction of train traffic, with parallel station platforms, as well as of the central and central-end types with short passages. Architectural solutions of stations with an organic combination of functional and esthetic elements. Highly effective systems of tunnel ventilation with new reversible devices; traction units at electrical substations with semiconductor rectifiers and dry transformers; as well as an automatic speed regulating system permitting an increase in carrying capacity of the lines. More economic and less labor-intensive components of deeply embedded stations: columnar with double-row cofferdams, and pylons with a reduced pier width. Large-size reinforced cement and aluminum watertight canopies for escalator tunnels. The technology and tunneling equipment for mechanized tunneling.

The experience of Leningradites, who in January of this year set a world record for digging tunnel runs in extending the Moscow-Petrograd line--1,250 m per month--gave a new impetus to the identification of organizational and technical reserves for increasing average construction rates in each specific geological engineering situation.

Our immediate program includes an increase in the industrial features of components and methods of building stations by the open method and vestibules; a reduction in their material consumption; and the adoption of tieless tracks convenient to operate, and other arrangements.

[Question] Speaking of architecture...

[Answer] The underground space limited to standardized dimensions and the absence of a facade in the ordinary meaning of the word regulate the work of the subway architect. Moreover, far from all finishing materials can be used because of operating conditions. The station type and its volumetric-spatial solution cannot vary within broad limits, since it depends directly on geological engineering. Nevertheless, there are many known achievements in our underground architecture. I believe they stem from the special attention to the architecture of subway stations and the creation here of a pleasing, artistically sonorous spatial environment. This is a priority of Soviet subway construction.

We proceed from the Moscow experience in developing an architectural concept of new subway lines. And it seems to me that we are departing further from the extremes in interpreting the architectural and artistic "filling" of stations which occurred in a number of instances, and approaching that reasonable measure of which much has been said but which is difficult to achieve. We still see attempts to oversaturate the appearance of subway stations in new cities.

Creative discussions of architectural plans greatly contribute to their improvement. It is advisable to hold such discussions not only in the final planning stage but even when the concept has jelled. In selecting means of architectural expression it is important to have a concrete disclosure of the interconnection of functional and esthetic elements. The organic alloy of architectural, artistic and engineering solutions subordinated to a specific idea and assuming a laconicism of architectural expressiveness is the backbone of this interconnection. I emphasize that a synthesis of architecture and the fine arts in the subway must bear not a mechanical, but a naturally merged character. The creative union of architect, artist and engineer is so necessary for this reason. The engineering interpretation and creation of the optimum structural basis is of great importance in the search for new volumetric-spatial solutions. One of the achievements of recent years was the rebirth of shallow, single-vault stations in Moscow, Khar'kov and Tashkent. A vault of variable section with internally broadened abutment and tie beam reinforced with spaced frames--that is the variety of single-vaulted stations of the Khar'kov subway. These components have been given seismic stability in Tashkent. The appearance of new arrangements in combination with a diversity of artistic treatment has enriched the architectural appearance of the subway as a whole.

The best models of underground architecture are being created in a unique, imaginative manner by developing national traditions in a truly innovative way and in the process of mutual enrichment of experience.

Every city where a subway is being built has many centuries of history. The interiors of subway stations uniquely recreate the spirit of revolutionary transformations and the traces of preceding centuries, and they accumulate the modern times rich in events. The ideological influence of the works of architecture is continuous, and the years are not lessening it.

[Question] What milestones in the further development of the Moscow subway are being planned today?

[Answer] The institute has begun a new phase for branching out the network of the capital subway in coordination with the long-range general plan for city development being drawn up by NIiPI Genplana [Scientific Research and Planning Institute for the General Plan]. Design decisions will be based on the radial-ring structure previously adopted and which has proven itself.

It is important to provide for a consolidation of the network and a more even distribution of passenger flows in connection with an increase in city size and size of the population. There unquestionably will be an increase in the number of diametrical lines. It will not be sufficient to have only the Ring Line as the distributor of passenger flows. In speaking of this, we also have to consider their expected increase in concentric directions.

Which is more advisable? A second ring or a combination of chord lines? Or perhaps a combined system of phased adjoining ring and chord sectors will be the most acceptable. The main criterion for our feasibility studies is the speed and convenience of transportation.

[Question] Won't the question of building express subway lines in Moscow arise in connection with this?

[Answer] I believe they will not be required in the foreseeable future. In New York, for example, express lines in combination with local lines in the Manhattan area were the result of an excessive concentration of passenger flows in a narrow, elongated territory, and in some other cities they are the result of an uncontrolled increase in travel distance on local lines.

It also has to be borne in mind that the gain in time of travel through a considerable increase in distances between stations turns out to be a loss for lesser travel distances. We adhere to the viewpoint that the lengths of runs must be set with consideration of providing comfortable movement for the majority of passengers.

The rationally planned outlines of the structural basis being developed for the capital subway will contribute to a further increase in flexibility of its system, the degree of carrying capacity, and speed indicators. Precise coordination in development of the subway and city construction depends on us to a certain extent.

[Question] Please comment on the basic provisions of general plans for development of other subways in the country.

[Answer] Consideration is given in developing the plans not only to future city construction, estimated passenger flows and the foci of their gravitation, but also to the principle of building a subway network providing an opportunity for traveling from any given point to any other with no more than one transfer. As a rule we are using systems of three or more lines with their intersection in a central part of the city. The triangle formed by the transfer junctions is the structural basis of the plan.

A successful design version was found in forming the subway network in Dnepropetrovsk. Not an intersection, but the contiguity of two lines at the same level with the shortest combined-type transfer has been provided in the vicinity of the future "Prospekt Il'icha" station. Approximately the very same decision was planned for the Moskovskaya station in Gor'kiy.

I would also like to highlight such important provisions of the general layouts as assurance of an effective interaction of subway lines with other types of transportation by creating multilevel traffic systems; and the organization of a uniform, maneuverable network of high-speed suburban-city lines by having subway lines adjoin railroads in peripheral areas. I believe that a redundancy of passenger vehicle parking areas in the vicinity of subway terminal stations also would be of significant importance. This should contribute to a comprehensive improvement in transportation services for the population.

Facts and Figures

The Glavtonnel'metrostroy [Main Administration for Construction of Tunnels and Subways] is the largest association of contracting, industrial and planning-design organizations carrying out the construction of subways, transportation tunnels and various underground facilities in our country.

There are 13 administrations of construction projects (trusts) with 86 primary line organizations engaged in building subways and tunnels. They are the territorial construction and installation administrations (trusts)--Mosmetrostroy, Lenmetrostroy, Kievmetrostroy, Tbiltonnel'stroy [Tbilisi Tunnel Construction], Baktonnel'stroy [Baku Tunnel Construction], Armtonnel'stroy [Armenian Tunnel Construction], Khar'kovmetrostroy, Tashmetrostroy [Tashkent Subway Construction], Bamtonnel'stroy [Baikal-Amur Railroad Tunnel Construction], Minskmetrostroy, Gormetrostroy [exact expansion unknown] and others. They are equipped with highly productive tunneling and construction machinery, have skilled personnel and have a well-developed industrial base. These administrations build complete subways and tunnel facilities under general contract conditions, using specialized organizations.

The conduct of scientific research and development of new models of equipment is the responsibility of the Tunnels and Subways Department of the All-Union Scientific Research Institute of Transport Construction and the SKTB [Special Design and Technological Bureau] of Glavtonnel'metrostroy.

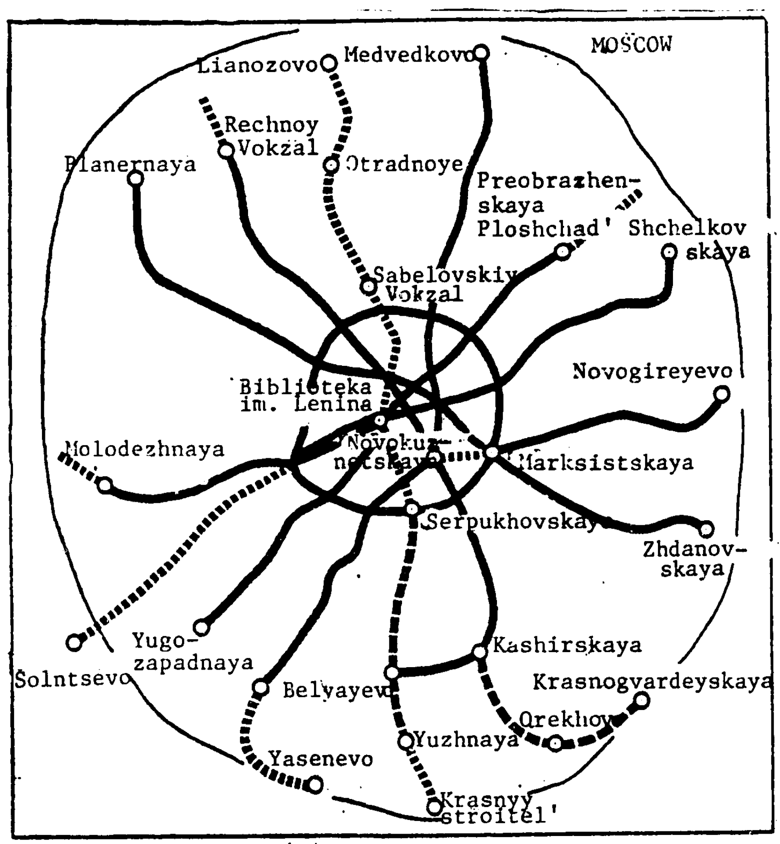
Thirteen industrial enterprises function in the Glavtonnel'metrostroy system. More than 220,000 m^3 of precast reinforced concrete, 360,000 m^3 of concrete commodities, 32,000 tons of cast iron tubing, and almost 10,000 tons of metal components are delivered to construction sites each year.

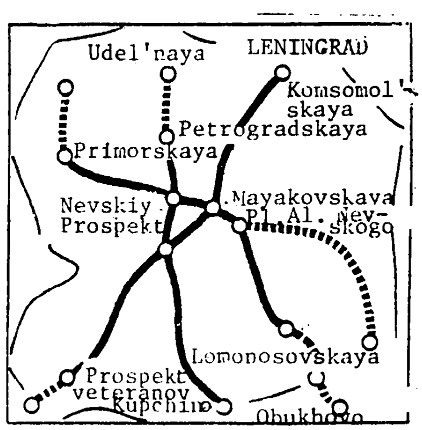
The manufacture of precast reinforced concrete components for tunnel casings is accomplished at ZhBK [reinforced concrete components] plants of construction administrations. The largest of them is the Ochakovo Plant of Mosmetrostroy.

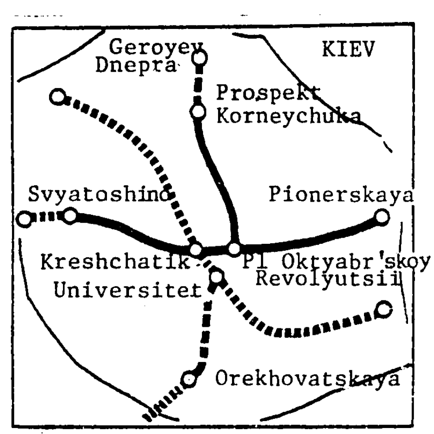
The Cherkizovskiy ZhBK Plant of Mosmetrostroy produces 40,000 m^2 of marble and 18,000 m^2 of polished granite each year for finishing subway stations.

Production of heading machines and tunnelling complexes and production of cast iron tubing for large-diameter tunnels (8.5 m and 9.5 m) has been organized at the Moscow Machinery Plant of Glavtonnel'metrostroy. Nonstandard equipment, vehicles, machinery and means of small-scale mechanization for all kinds of tunneling work are manufactured at this same enterprise as well as at machinery plants of construction administrations.

The Moscow Subway network is 193 km long with 115 stations; the Leningrad Subway is 71.6 km long with 41 stations; the Kiev Subway--28.4 km with 21 stations; the Tbilisi--19 km with 16 stations; the Baku--21.9 km with 12 stations; the Khar'kov--18.2 km with 13 stations; the Tashkent--16.7 km with 12 stations; and the Yerevan Subway is 7.6 km long with 5 stations.



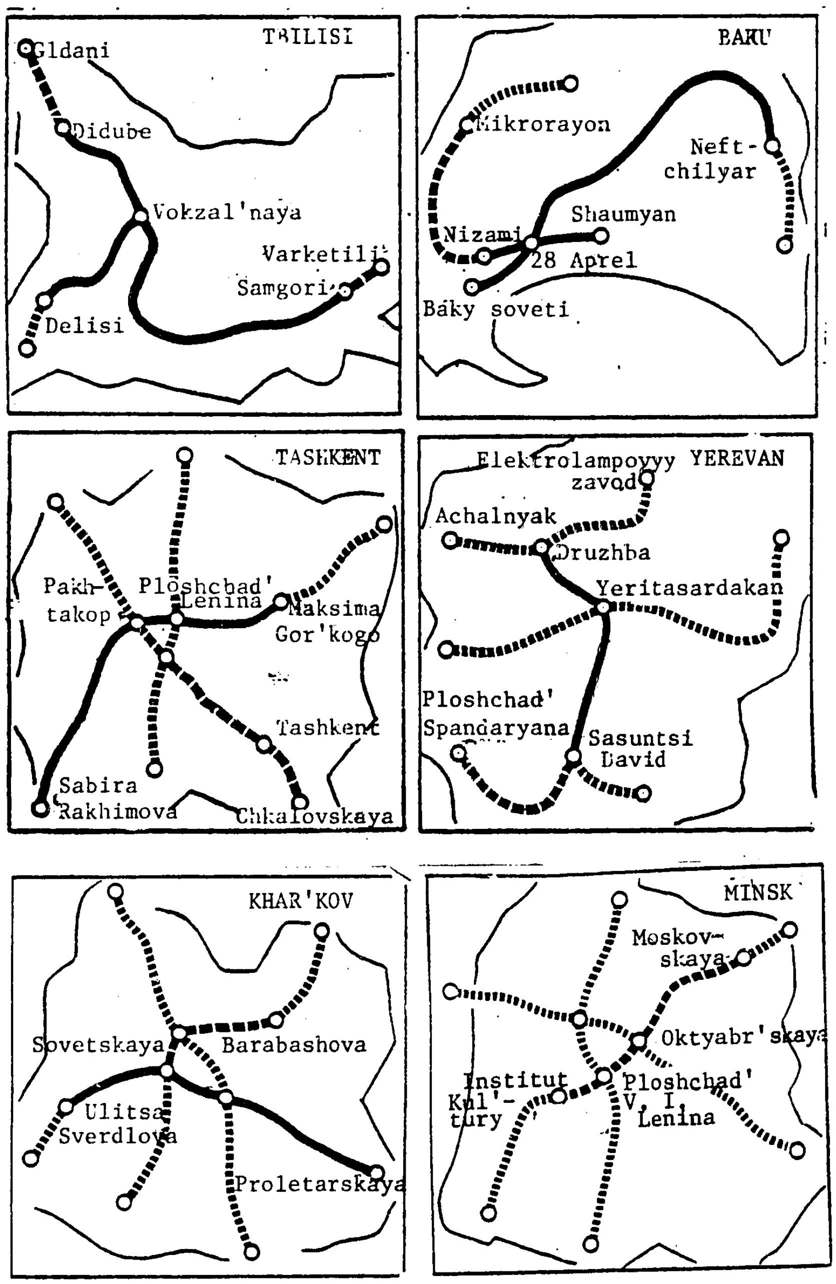




Existing lines

Under construction

Future lines



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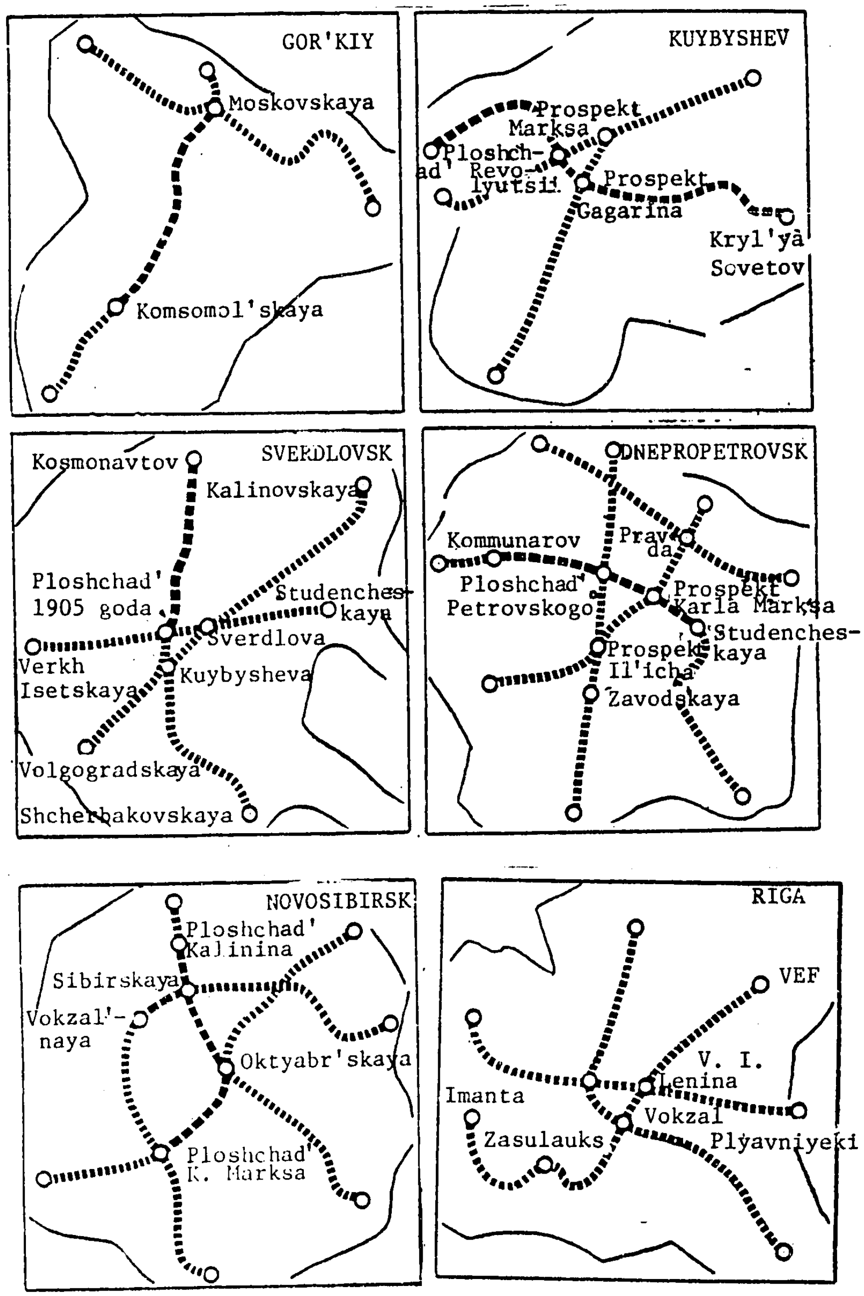
GOR'KIY
Moskovskaya
Komsomol'skaya
KUYBYSHEV
Prospekt
Marksa
Ploshch-
ad' Revo-
lyutsii
Prospekt
Gagarina
Kryl'ya
Sovetov
SVERDLOVSK
Kosmonavtov
Kalinovskaya
Ploshchad'
1905 goda
Studenches-
kaya
Sverdlova
Verkh
Isetskaya
Kuybysheva
Volgogradskaya
Shcherbakovskaya
DNEPROPETROVSK
Kommunarov
Pravda
Ploshchad'
Petrovskogo
Prospekt
Karla Marksa
Studenches-
kaya
Prospekt
Il'icha
Zavodskaya
NOVOSIBIRSK
Ploshchad'
Kalinina
Sibirskaya
Vokzal'-
naya
Oktyabr'skaya
Ploshchad'
K. Marksa
RIGA
VEF
V. I.
Lenina
Imanta
Vokzal
Zasulauks
Plyavniyeki

Stages of the Great Path (Chronicle of Construction Starts)

	Length, km	Nr of stations	Year in operation
Moscow			
Operating			
1st Section			
Kirovskiy Radius: Sokol'niki-Park kul'tury .... Arbatskiy Radius: Kalininskaya-Smolenskaya	11.6	13	1935
2d Section:			
Arbatskiy Radius: Smolenskaya-Kievskaya	1.3	1	1937
Pokrovskiy Radius: Ploshchad' Revolyutsii-Kurskaya	2.4	2	1938
Gor'kovskiy Radius: Ploshchad' Sverdlova-Sokol	9.6	6	1938
3d Section:			
Zamoskvoretskiy Radius:			
Ploshchad' Sverdlova-Avtozavodskaya	6.5	3	1943
Pokrovskiy Radius: Kurskaya-Izmaylovskiy park	7	4	1944
4th Section:			
Kol'tsevaya liniya: Park kul'tury-Kurskaya	6.7	6	1950
Kurskaya-Belorusskaya	6.9	4	1952
Arbatskiy Radius: Arbatskaya-Kievskaya	4.5	3	1953
Kol'tsevaya liniya: Belorusskaya-Park kul'tury	5.8	2	1954
Pokrovskiy Radius: Izmaylovskiy park-Pervomayskaya*	1.3	1	1954
Frunzenskiy Radius: Park kul'tury-Sportivnaya	2.5	2	195 [sic]
Rizhskiy Radius: Prospekt Mira-VDNKh	5.4	4	1958
Filevskiy Radius: Kievskaya-Kutuzovskaya	2.1	2	1958
Frunzenskiy Radius: Sportivnaya-Universitet	4.5	2	1959

*The previously operated run was closed with the opening of the new Izmaylovskiy park-Izmaylovskaya sector.

[Continued from previous page]

	Length, km	Nr of stations	Year in operation
Moscow			
Operating			
Filevskiy Radius:			
Kutuzovskaya-Fili	1.4	1	1959
Pokrovskiy Radius:			
Izmaylovskiy park-Pervomayskaya	3.2	2	1961
Filevskiy Radius:			
Fili-Pionerskaya	4.6	3	1961
Kaluzhskiy Radius:			
Oktyabr'skaya-Novyye Cheremushki	8.9	5	1962
Pokrovskiy Radius:			
Pervomayskaya-Shchelkovskaya	1.8	1	1963
Frunzenskiy Radius:			
Universitet-Yugo-Zapadnaya	4.4	2	1963
Kaluzhskiy Radius:			
Novyye Cheremushki-Kaluzhskaya	1.7	1	1964
Gor'kovskiy Radius:			
Sokol-Rechnoy vokzal	6.5	3	1964
Filevskiy Radius:			
Pionerskaya-Molodezhnaya	3.9	2	1965
Kirovskiy Radius:			
Sokol'niki-Preobrazhenskaya ploshchad'	2.6	1	1965
Zhdanovskiy Radius:			
Taganskaya-Zhdanovskaya	14.5	7	1966
Zamoskvoretskiy Radius:			
Avtozavodskaya-Kakhovskaya	9.6	4	1969
Kaluzhskiy Radius:			
Oktyabr'skaya-Ploshchad' Nogina	4.2	2	1970
Zhdanovskiy Radius:			
Taganskaya-Ploshchad' Nogina	2.1	1	1970
Rizhskiy Radius:			
Ploshchad' Nogina-Prospekt Mira	3.2	2	1971
Krasnopresnenskiy Radius:			
Barrikadnaya-Oktyabr'skoye pole	8.1	5	1972
Kaluzhskiy Radius:			
Novyye Cheremushki-Belyayevo	3.8	2	1974
Krasnopresnenskiy Radius:			
Ploshchad' Nogina-Barrikadnaya	3	2	1975
Oktyabr'skoye pole-Planernaya	9.7	4	1975

[Continued from previous page]

	Length, km	Nr of stations	Year in operation
Moscow			
Operating			
Rizhskiy Radius:			
VDNKh-Medvedkovo	8.3	4	1978
Gor'kovskaya		1	1979
Kalininskiy Radius:			
Marksistskaya-Novogireyevo	12	6	1979
Shabolovskaya		1	1980
Under Construction			
Serpukhovskiy Radius:			
Serpukhovskaya-Yuzhnaya	13.9	8	1983
Zamoskvoretskiy Radius:			
Kashirskaya-Orekhovo	6.4	3	1984
Serpukhovskiy Radius:			
Serpukhovskaya-Biblioteka im. Lenina	2.8	2	1984
Zamoskvoretskiy Radius:			
Orekhovo-Brateyevo	3.4	2	1985
Kalininskiy Radius:			
Marksistskaya-Novokuznetskaya	1.6	1	1985
Future			
Serpukhovskiy Radius:			
Yuzhnaya-Krasnyy mayak	1.3	2	1985
Kaluzhskiy Radius:			
Belyayevo-Yasenevo	6.5	4	1986
Serpukhovskiy Radius:			
Krasnyy mayak-Krasnyy stroitel'	3.3	2	1987
Timiryazevskiy Radius:			
Novoslobodskaya-Ul. Rustaveli Ul. Rustaveli-Otradnoye	11.5	7	1988
Novoslobodskaya-Biblioteka im. Lenina	3.5	2	1989
Leningrad			
Operating			
Kirovsko-Vyborgskaya Line:			
Avtovo-Ploshchad' Vosstaniya	10.8	8	1955
Ploshchad' Vosstaniya-Ploshchad' Lenina	3.4	2	1958
Moskovsko-Petrogradskaya Line:			
Tekhnologicheskiy institut-Park Pobedy	6.6	5	1961
Tekhnologicheskiy institut-Petrogradskaya	5.9	4	1963

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	Length, km	Nr of stations	Year in operation
Leningrad			
Operating			
Kirovsko-Vyborgskaya Line:			
Avtovo-Dachnoye	1.5	1	1966
Nevsko-Vasileostrovskaya Line:			
Vasileostrovskaya-Ploshchad' Aleksandra Nevskogo	8.2	4	1967
Moskovsko-Petrogradskaya Line:			
Park Pobedy-Moskovskaya	2.2	1	1969
Nevsko-Vasileostrovskaya Line:			
Ploshchad' Aleksandra Nevskogo-Lomonosovskaya	6.1	2	1970
Moskovsko-Petrogradskaya Line:			
Moskovskaya-Kupchino	4.5	2	1972
Kirovsko-Vyborgskaya Line:			
Ploshchad' Lenina-Lesnaya }	8.75	2	1975
Lesnaya-Akademicheskaya }		3	1975
Avtovo-Prospekt Veteranov	3.6	2	1977
Akademicheskaya-Komsomol'skaya	5.3	2	1978
Nevsko-Vasileostrovskaya Line:			
Vasileostrovskaya-Primorskaya	2.36	1	1979
Lomonosovskaya-Obukhovo	3.84	2	1981
Under Construction			
Moskovsko-Petrogradskaya Line:			
Petrogradskaya-Udel'naya	6.8	3	1982
Pravoberezhnaya Line:			
Ploshchad' Aleksandra Nevskogo-Ul. Kollontay	6.9	4	1985
Future			
Nevsko-Vasileostrovskaya Line:			
Obukhovo-Rybatskoye	3.7	1	1984
Pravoberezhnaya Line:			
Ploshchad' Aleksandra Nevskogo-Ploshchad' Mira	4.3	3	1986
Moskovsko-Petrogradskaya Line:			
Udel'naya-Parnasskaya	5.5	2	1987
Pravoberezhnaya Line:			
Ul. Kollontay-Ul. Narodnaya	4.4	2	1988
Zhdanovsko-Frunzenskaya Line:			
Ploshchad' Mira-Bogatyrskiy prospekt	9.3	6	1989
Ploshchad' Mira-Ul. B. Kuna	7	5	1990

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	Length, km	Nr of stations	Year in operation
Kiev			
Existing			
Svyatoshino-Brovarskaya Line:			
Vokzal'naya-Dnepr	5.2	5	1960
Vokzal'naya-Zavod "Bol'shevik"	3.3	2	1963
Dnepr-Darnitsa	4.4	3	1965
Darnitsa-Komsomol'skaya	1.3	1	1968
Zavod "Bol'shevik"-Svyatoshino	4.5	3	1971
Kurenevsko-Krasnoarmeyskaya Line:			
Ploshchad' Kalinina-Krasnaya ploshchad'	3.3	3	1976
Svyatoshino-Brovarskaya Line:			
Komsomol'skaya-Pionerskaya	1.7	1	1979
Kurenevsko-Krasnoarmeyskaya Line:			
Krasnaya ploshchad'-Prospekt Korneychuka	4.7	3	1980
Under Construction			
Kurenevsko-Krasnoarmeyskaya Line:			
Pl. Oktyabr'skoy Revolyutsii-Tsentral'nyy stadion	2.1	2	1981
Prospekt Korneychuka-Geroyev Dnepra	2.3	2	1982
Tsentral'nyy stadion-Orekhovatskaya ploshchad'	4	4	1985
Future			
Syretsko-Pechorskaya Line:			
Zolotyye vorota-Mechnikova	3.1	3	1986
Tbilisi			
Existing			
1st Section:			
Didube-Rustaveli	6.3	6	1966
Rustaveli-300 aragvintsev	4	3	1967
300 aragvintsev-Samgori	2.5	2	1971
2d Section:			
Vokzal'naya-Delisi	6.2	5	1979
Under Construction			
1st Section:			
Didube-TEVZ	4.2	2	1984
TEVZ-Gldani	2.35	2	1985
Samgori-Varketili	2.04	1	1985
Future			
1st Section:			
Bol'shoye Digomi-Moskovskiy prospekt	24.2	17	

[Continued from previous page]

	Length, km	Nr of stations	Year in operation
Baku			
Existing			
1st Section:			
Baky Soveti-Narimanov	10	6	1967
2d Section:			
28 Aprel-Shaumyan	2.2	1	1968
1st Section:			
Narimanov-platforma Depo	0.72		1970
Narimanov-Ulduz	2.3	1	1970
Ulduz-Neftchilyar	5.1	3	1972
28 Aprel-Nizami	2.3	1	1976
Under Construction			
2d Section:			
Nizami-Mikrorayon	6.7	4	1983
Future			
Mikrorayon-Ulduz	8	5	
Neftchilyar-Akhmedly	6	4	
28 Aprel		1	
Khar'kov			
Existing			
Sverdlovsko-Zavodskoy Diameter:			
Ulitsa Sverdlova-Moskovskiy prospekt	10.6	8	1975
Moskovskiy prospekt-Proletarskaya	7.6	5	1978
Under Construction			
Saltovsko-Shevchenkovskiy Diameter:			
Sovetskaya-Barabashova	7.7	5	1984
Barabashova-Geroyev Truda	3.3	3	1985
Future			
Alekseyevsko-Gagarinskaya Line:			
Prospekt Pobedy-Odesskaya	15	11	1985
Tashkent			
Existing			
1st Section:			
Sabira Rakhimova-Oktyabr'skoy Revolyutsii	12.2	9	1977
Oktyabr'skoy Revolyutsii-Maksima Gor'kogo	4.5	3	1980
Under Construction			
2d Section:			
Pakhtakor-Tashkent	5.5	5	1985

[Continued from previous page]

	Length, km	Nr of stations	Year in operation
Tashkent			
Future			
Tashkent-Aviagorodok	2.2	2	1987
Yerevan			
Existing			
1st Section:			
David Sasuntsi-Druzhba	7.6	5	1981
Under Construction			
David Sasuntsi-Ploshchad' Spandaryana	3.9	3	
Oktemberyan		1	
Future			
2d Section:			
Druzhba-Elektrolampovyy zavod	5	3	
Druzhba-Achapnyak	3.5	2	
Minsk			
Under Construction			
Moskovskaya-Institut kul'tury	8.65	8	1984
Future			
Moskovskaya-Vostok	1.75	1	
Prospekt Pushkina-Avtozavodskaya	13.4	10	
Gor'kiy			
Under Construction			
Moskovskaya-Komsomol'skaya	9.6	8	1984
Future			
Kalininskaya-Gor'kovskaya	8	4	
Moskovskaya-Meshcherskiye ozera	2.7	1	
Novosibirsk			
Under Construction			
Leninskaya Line:			
Krasnyy prospekt-Studencheskaya	8.46	6	1985
Sibirskaya-Vokzal'naya	1.8	2	
Future			
Leninskaya Line:			
Krasnyy prospekt-Ploshchad' Kalinina	2.4	2	
Studencheskaya-Ploshchad' Karla Marksa	1.54	1	

[Continued from previous page]

	Length, km	Nr of stations	Year in operation
Kuybyshev			
Under Construction			
Oktyabr'skaya-Kirovskaya	11.2	9	1983
Future			
Oktyabr'skaya-Ploshchad' Revolyutsii	4.4	3	
Kirovskaya-Kryl'ya Sovetov	2.2	1	
Sverdlovsk			
Under Construction			
1st Section:			
Chkalovskaya-Prospekt Kosmonavtov	11.5	9	1988
Dnepropetrovsk			
Under Construction			
1st Section:			
Kommunarovskaya-Oktyabr'skaya ploshchad'	11.82	9	
Future			
2d Section:			
Zavodskaya-Pravda	9.81	5	
Riga			
Future			
1st Section:			
VEF-Zasulauks	8.9	8	
Zasulauks-Imanta	4.3	3	
2d Section:			
Ploshchad' Lenina-Plyavniyeki	5.9	5	

The Contribution to the Depository of Subway Construction

Leningrad:

The performance of high-speed tunneling at the Lenmetrostroy has become a tradition already numbering more than three decades.

In 1949 a creative collective of scientific workers, designers and builders of Lenmetrostroy made the first Soviet mechanized heading machine. Beginning in 1950 all the tunnel runs of the Leningrad Subway have been built with mechanized heading machines.

The design of the KT 1-5.6 mechanized tunneling system was developed, with an arched conveyor block placer for installing casing pressed into the rock.

Technology is being created for through heading of lateral tunnels using mechanized systems in a uniform cycle with adjoining tunnel runs; working of the rock and installation of the upper vault of a single-vault station is being mechanized.

Precast reinforced concrete casing of tunnel runs has been introduced, using units of a simple form, assembled and pressed into the rock. In comparison with types used previously, this type of casing provides an opportunity to increase tunneling rates, to reduce consumption of material and labor expenditures, and to raise the quality and working conditions of production.

Deep, single-vault stations have been built.

The principle of pressing the casing into the rock is implemented for vaults of large span in building single-vault stations.

The design of columnar stations is perfected. Steel columns rest through blocks on the lower monolithic reinforced concrete beam, which in turn hinges on precast reinforced concrete units closing the lower part of the casing. Such a design decision permits using the additional volume obtained for accommodating offices.

Reinforced cement components were introduced, particularly large-component watertight canopies for stations and escalator tunnels. They are installed in the form of triple-hinged arches which are not connected with the main bearing casing, and they have high technological, operating and architectural qualities.

Automatic control of train traffic is established on the basis of a centralized programming-modeling system.

An automated system for control of the technological process (ASUTP) is being developed. This work is broken into several phases. In the first, which is to be completed in 1982, the work of the mine surveyor and heading machine operator will be replaced by an EVM [electronic computer]. It is planned to automate rock loading and mechanize the delivery and installation of bands. One person will direct these operations from a console. In subsequent phases automation is to take in all processes, including hauling the rock and taking it to the surface.

A brineless freezing of soils has been introduced, using liquid nitrogen which vaporizes in the refrigerating column (without refrigeration units). Thanks to the low evaporation temperature of liquid nitrogen (-195°), nine times less time is spent for freezing.

Kiev:

In constructing the Arsenal'naya Station in sticky clays and fluid loams an intermediate vestibule was built at the surface and lowered to the design level under the protection of an ice and soil wall.

The deep Polytechnical Institute Station was built of precast reinforced concrete components.

In cutting the city gravity-flow collector in clay soils, a casing was introduced made of reinforced concrete units stressed by being thrust against the rock by the opening of a wedge block. This allowed complete elimination of injection and a reduction in consumption of reinforcement by 3-4 times.

The technology of building tunnels with single-section casings was developed, using the KMO-1 mechanized system.

Tbilisi:

A casing of single-section units 1.5 m long was used in building shallow runs between the Komsomol'skaya and Delisi stations.

Centrifugally precast, prestressed columns with spiral reinforcement and with high bearing power were installed in the Isani and Prospekt Tsereteli stations. The columns weigh 3.5 tons with an outer diameter of 64 cm. The components are economical, transportable and easily installed.

Two deep single-vault stations (Polytechnical Institute and Vokzal'naya-II) were built in rocky soil out of monolithic concrete and reinforced concrete.

A complex was built consisting of a mechanized underground passage with horizontal platform passenger conveyors from the Samgori subway station to the Kakhetinskiy Highway. The passage was built under difficult conditions under 13 operating railroad tracks without interrupting train traffic. Carrying capacity of the conveyor in one direction is 61,000 persons per hour.

Baku:

A working method was used involving the simultaneous use of a caisson and deep water drawdown in tunneling between the 26 Baky komissary and the 28 Aprel stations in fine sandy loams alternating with clays and in sandy loams with a hydrostatic ground water pressure of 4.5 gauge atmospheres.

The 28 Aprel-Nizami tunnel runs were built under difficult hydrogeological conditions by the heading method in combination with a caisson, water draw-down, freezing and cementation.

A standardized reinforced concrete casing made of continuous section units with circular joints without connections has been used in tunnel run sectors.

Wide use has been made of glued, bituminized, waterproof rolled materials made on a cellular fiberglass basis--fiberglass roofing material and bituminized fiberglass in place of waterproofing on bituminous cement.

Khar'kov:

A design has been introduced of a single-vault station built by the open method with a monolithic reinforced concrete vault installed by using movable metal form work. This permits diversifying the architectural finishing of the vault by applying various elements on the form work.

A method has been used for reinforcing silt-sand soils with a heavy inflow of ground waters (on the Sovetskaya-Prospekt Gagarina run) by means of injecting chemical reagents through special holes bored in the tunnel casing. Carbamide resins (UKS [exact expansion unknown]) with a K bond were used as the binder, while a three-percent solution of oxalic acid was used to speed up gelatinization.

The Dzerzhinskaya columnar station is being built with a platform 13 m wide, and column spacing was increased to 9 meters at the Barabashova station.

The progressive flow line method of building facilities has been adopted everywhere, which reduces construction time 15-20 percent and lowers labor input 20-30 percent and production cost 12-15 percent.

Tashkent:

The problem has been solved concerning seismic stability of station components and subway tunnel runs being laid down in very moist, unstable loessial rock. Components, made of precast and monolithic reinforced concrete, are designed not only for receiving permanent and temporary loads, but also for the action of inertial forces of rock movement during an earthquake. Maximum use is being made of precast components with continuous longitudinal rigid and yielding seismic bands.

The method of erecting a casing pressed into the rock under conditions of erector tunnelling has been tested in building the run between the Pakhtakor and Ploshchad' Lenina stations.

Yerevan:

A casing of precast reinforced concrete units with cylindrical joints without tension braces and with two supplementary inserts has been developed for building tunnel runs. A reinforced concrete jacket with metal insulation is installed within the component. The metal saved per running meter is 4,152 kg.

New types of ties--welded angle braces between units and tie bolts along the axis of elements--have been developed for the purpose of preventing the deformations of sectional rings of casings from seismic forces. The ties consist of metal rods 18 mm in diameter, embedded in holes with expanding cement.

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MISCELLANEOUS

IMPROVED TRANSPORTATION SYSTEMS NEEDED FOR TYUMEN

Moscow NEFTYANAYA PROMYSHLENNOST' SERIYA NEFTEPROMYSLOVOYE STROITEL'STVO in Russian No 8, 1981 pp 16-18

[Article by V.A. Vasilyuk: "The Economic Problems of Improving Transportation Services For the Tyumen' Petroleum and Gas Extracting Region"]

[Text] Transportation availability is one of the basic factors in the development of the petroleum and gas extracting areas of Tyumenskaya Oblast. At the present time the extracting industry of the Middle Priob'ye is shifting to the north and natural-climatic and economic-geographic conditions are changing. The lake and swamp density of these territories comes to 80 percent. The new deposits have different geological characteristics which make the process of drilling difficult and reduce productivity and the average yield of each new well compared to the Middle Priob'ye. As a result of this, the volume of freight being supplied for drilling has been increasing substantially. The transportation system which serves the petroleum and gas extracting industry of the Tyumen' North includes railroad, river, maritime, motor vehicle, and air transport. All of the mainlines are isolated and removed from one another by 200-500 kilometers.

The geographic location and length of the existing railroad network does not fully meet the needs of the areas extracting hydrocarbon raw materials. New railroad lines which would ensure the delivery of freight without excessive transshipments are needed. Practice shows that when freight is delivered by mixed transportation methods the cost of the hauls is lowered, but the expenditures for loading and unloading operations increase substantially. In addition, with fivefold transshipments 15-20 percent of the freight is ruined while in route. The Main Administration for Petroleum and Gas in Tyumenskaya Oblast brings in 98 percent of its material and technical resources by railroad, and of this amount, only 40 percent directly into the petroleum extracting areas, and the other 60 percent is transferred onto river vessels and delivered to the bases of associations in the extraction areas. Then some of the freight is transferred to small ships and delivered to the deposits on small rivers, some of the freight is taken to the deposits by motor vehicle transport, and the rest is kept at the bases until the onset of winter and the beginning of the operation of winter roads. The winter roads are used for delivering as much as 700,000 tons of freight to the deposits. The development of the railroad network and an increase in the amount of freight deliveries by the Northern Sea Route has not decreased the role of river transport. The rivers of the Ob'-Irtysh basin continue to be chief waterways. Within Tyumenskaya Oblast the navigable river system includes the rivers Ob', Irtysh, Tura, Tobol, Agan, Vakh, Lyamin, and also Pur, Taz, and Nadym. In the latitudinal current of the Ob' the river fleet performs hauls 160-190 days, and at the more northern small rivers and the Nizhnyaya Ob'--from 120 to 80-30 days.

Motor vehicle transportation performs most of the freight hauls in the petroleum and gas extracting areas. The relationship between interfield and intrafield motor roads with basic servicing is 2:1. On the average, there are 4.5 units of motor vehicle-tractor equipment per kilometer of motor vehicle roads with basic serfacing in the Tyumen' North. The increase in the need for such equipment is connected with the constantly increased difficulties in developing new deposits. In the future the need for this equipment will increase.

The experience connected with developing the deposits of the Tyumen' petroleum and gas extracting region has demonstrated the necessity for an overall approach to improving the transportation system. Different types of transportation are used in internal and external freight hauls, sometimes without regard to economic expediency. In the development of new deposits intra-area and inter-field freight hauls will be performed at the level of 80 percent by motor vehicle transport, and the rest by helicopters (more rarely, airplanes). At the present time the lowest cost for freight hauls is on river transport, and the highest on railroads. Most of the freight is brought to the Tyumen' North by river transport during the navigation period whose length is around five months in the north Priob'ye, and not more than four months in the Far North. As a result of the seasonal operation of river transport it is necessary to equip bases for the storing of material and technical resources, which leads to a substantial "freezing" of resources.

In recent years the freight turnover of the riverports has been increasing annually and, for this reason, a large part of the freight is delivered through southern ports with a large overrun, which with the short navigation period reduces the indicators of fleet use.

The experience in operating one of the railroads in this area during 1975-1980 shows a decrease in transportation expenditures in petroleum field construction. However, at the same time, on account of an insufficiently developed network of inter-field motor vehicle roads with hard cover, which holds back the work of the motor vehicle pool, the share of transportation expenditures increases. The overall tendency in a change of transportation expenditures and the additional expenditures connected with them can also be traced in analysis of the expenditures related to one million rubles of construction and installation work. To a substantial degree an improvement of railroad and motor vehicle freight flows will be promoted by an expansion of the network of rail and motor roads. New lines will ensure supply for the petroleum and gas extracting industry and for construction subdivisions. However, to develop a system of motor vehicle roads in the Pripolyar'ye on the basis of increasing the length of dirt-log roads and winter roads is economically inexpedient. It is essential to have a scientifically substantiated technology for the construction of inexpensive and reliable motor vehicle roads. Otherwise, it would be expedient to build railroad lines. Let us examine an example. The amount of earth work in making an embankment for motor vehicle and railroads at a given latitude is the same, and the upper part of the construction of a motor vehicle road in its amount of cost is more and its operational periods are shorter than a railroad. With a minimum width of the motor vehicle road of six meters per kilometer it is necessary to have 850 cubic meters of ferroconcrete plates, and on the rail base with a width of two meters (replacing the ballast and ties with ferroconcrete plates or frames)-200 cubic meters. When freight intensity falls off the rails and the under-rail foundation can be used repeatedly on newly built inter-field lines, while the motor vehicle road plates quickly become unserviceable as a result of active cryogen processes.[1] At this latitude the valley river complexes have sands, pebbles, and sandy loam; the water divide sectors are more frequently represented by sandy loams, loams, and clays. Since the vegetation and soil strata are of negligible strength, dirt can be taken by the open method for the earthen right-of-way; in zones where thawed ground is widespread hydromechanization is used. The forced development of the transportation system is the result of the tendency for construction industry enterprises to move near to the sites of industrial and housing construction.

It would be useful to create enterprises for the production of road cover plates involving the thermal processing of ferroconcrete products. Local small grade sand is used to prepare heavy concrete; one cubic meter of mass for 2.4 tons of products. The on-site production of road cover plates will make it possible to decrease the cost of road surfacing by 50 percent. However, the problem of intra-area freight hauls and of the thoroughfare importation of freight cannot be solved solely through the construction of inter-field roads and railroads. It is clear that in the North river transport will preserve its leading place for a long time, while urgent freight will be delivered from the bases to deposits by aviation.

In the development of the most remote petroleum deposits the basic freight will be delivered by motor vehicle transport on winter roads, while during the warm time of the year this will be done by aviation (helicopters). The MI-8 and MI-6 helicopters are the basic ones in the petroleum extracting areas. In order to improve the transportation network in the North it is necessary first of all to solve the problems of the siting and construction of support railroads, and also of railroad branches to individual deposits, railroad sidings, dead ends, and areas; and to determine the economic and geographic rationality of siting a network of motor vehicle inter-field roads with hard-top surfacing. This will make it possible to decrease the river freight flow and, consequently, the additional construction of storage bases, and also hauls on winter roads. It is also necessary to substantially decrease the use of expensive air transport for inter-field communications.[2]

The chief task of the development of the transportation system is to provide the necessary material and technical resources for areas where petroleum and gas deposits are being developed. It is advisable to create a support transportation network in an area out of railroad lines and hard-top motor vehicle roads. This will make it possible to decrease the adduced expenditures per ton of freight by ten times compared to the supply system which has developed.

In order to increase the capacity of permanent railroads it is necessary to build sidings and loading and unloading areas and to raise the level of the mechanization of loading and unloading work.

The successful work of river transport in petroleum and gas extracting areas needs an improvement of the condition of piers, an expansion of the sphere of river transport on small rivers by means of lengthening, an increase in the transshipment capacities of ports, and the construction of new and expansion of existing take-off and landing strips at a number of deposits. A further increase in petroleum and gas extraction in the Tyumen' region depends upon the correct solution of th_ problems of improving the transportation system.

FOOTNOTES

1. A.V. Gruzdov, "Neslivayushchiyesya merzlotnyye porody v pripolyarnykh rayonakh Zapadnoy Sibiri," "Prirodnyye Usloviya Zapadnoy Sibiri," No. 7, MGU, Moscow, 1980.

2. I.D. Karyagin and V.S. Bulatov, "Razvitiye gazovoy promyshlennosti Severa Tyumenskaya Oblast, " Moscow, "Nedra," 1979.

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